The Marine Laboratory
UNIVERSITY OF MIAMI

INTERNATIONAL GAME FISH CONFERENCE

Miami Beach, Florida. November 16, 1960

held under the auspices of the

INTERNATIONAL
OCEANOGRAPHIC
FOUNDATION

and the

GULF AND CARIBBEAN FISHERIES INSTITUTE

MIAMI 49, FLORIDA

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MORNING SESSION:
Chairman: C. Richard Robins

AFTERNOON SESSION:
Chairman: Louis S. Mowbray

RESULTS OF WORK CONDUCTED BY THE MARINE LABORATORY IN 1960 IN NEW ZEALAND AND MEDITERRANEAN WATERS

presented by

Walter A. Starck, II

THE MARINE LABORATORY
University of Miami

at the Fifth

INTERNATIONAL GAME FISH CONFERENCE

Miami Beach, Florida

November 16, 1960

RESULTS OF WORK CONDUCTED BY THE MARINE LABORATORY IN 1960 IN NEW ZEALAND AND MEDITERRANEAN WATERS

by Walter A. Starck II

The Marine Laboratory, University of Miami

Introduction

Within the past year I have had the good fortune to be able to accompany two expeditions affiliated with the University of Miami Marine Laboratory, one to New Zealand, the other to the western Mediterranean. The primary purpose of both was to gain further information about the billfish.

New Zealand

The work in New Zealand was sponsored by Mr. Edwin J. Gould through the Marine Laboratory and extended from February through March of this last year. Members of the expedition were: Louis Mowbray and Capt. Red Stuart, well known to most of you at the conference; Mr. John J. Moreland, an ichthyologist from the Dominion Museum in Wellington, New Zealand; Capt. Roy Taylor of Bermuda; John Biddle, photographer; Mr. Gould and Mrs. Gould and several guests. The area studied was the Bay of Islands: a large bay filled with numerous small hilly islands, located on the northeast coast of North Island, N. Z. This area has been a world famous big game fishing center ever since Zane Grey fished there in 1926. It is of interest ichthyologically not only because of the large pelagic fishes which abound there, but also because of the numerous other fishes, many of which are endemic to New Zealand. Large schools of bait fish abound there. The deep water comes in to the shore making this a natural concentration point for larger pelagic gamefishes as the marlins, tunas, and sharks. We spent four weeks here, from mid-February to mid-March, 1960. During our stay, 18 marlin were brought in and examined. Of them, two were blue marlin (Makaira nigricans), two were black marlin (Makaira indica), and 14 were striped marlin (Tetrapturus audax). Both black marlin, one of the blue marlin, and two of the striped marlin were caught by Mr. Gould. The larger of the black marlin (700 pounds), is a New Zealand record on 80 pound test line. A blue marlin which was caught by Mr. Gould on 80 pound test line weighed 462 pounds and is now the world record Pacific blue marlin in this line test class. However, I have obtained a photograph of the all tackle world record "striped" marlin which was caught off Balboa, California and weighed 692 pounds. This fish was also caught on 80 pound test line and from examination of the photograph there is little doubt that it is a blue marlin. If and when the IGFA corrects this in their list of world record marine game fishes it will become the record Pacific blue marlin

in the 80 pound line test class. At present we believe the Atlantic and Pacific blue marlin to be the same species. However, for the purpose of records, I think it will be useful to keep them separate as is now done by the IGFA.

Many marlin caught at the Bay of Islands are taken very close to shore, especially the black marlin. That they are feeding in these areas is indicated by the stomach contents (Table I). Both the schnapper (a sparid) and the pink maomao (a serranid) are primarily bottom-living fishes and yet are commonly found in the stomach of marlin as can be seen from the table. Kahawai (an arripid), the preferred bait in this area is notable by its absence in stomach contents. Probably it is not normally available to the marlin, being generally found only in the bays. When made available, however, it appears to be readily taken by the marlin. Istiophorids in general are well known for the great variety of their stomach contents, taking apparently whatever is available to them.

A possible function of the rigid pectoral fin in the black marlin was also noted in examining this species. There has been speculation among ichthyologists as to the function of this nonretractable fin. Upon examining the two black marlin caught on this expedition, it was noticed that the black marlin's pectoral fin forms a near perfect hydrofoil which is readily observable when the fin is cross sectioned, whereas the blue and striped marlins have normal retractable pectoral fins which are almost symmetrical in cross section. In addition, there is much less flesh between the rays of this fin in the black marlin than in the blue or the striped marlin, making it on the whole a much more rigid structure. As to the function this serves, it is obvious that this fin when moved through the water would afford a certain amount of lift probably in compensation for the depressing effect of the steeper forehead and more anterior center of gravity of the black marlin.

In addition to the marlin examined, several sharks were caught during our stay at the Bay of Islands. One of these was a very small Mako weighing only 12 pounds and another was a hammerhead containing 20 young.

Collections of smaller fishes were also made by means of poison, spears, nets, etc. These collections range from tide pools, exposed at low tide, to a depth of 180' with aqua lungs. In all, about 75 species of small fish were taken of which 5 are believed to be new to science.

Mediterranean

From mid-July to Mid-September this year I accompanied Col. J. K. Howard of the Marine Laboratory to the Mediterranean. The purpose of our work in the Mediterranean was again concerned with gaining

information about billfishes. Our first objective was to make arrangements to obtain specimens of the Mediterranean spearfish, Tetrapturus belone for comparison with our western Atlantic species. We also hoped to obtain information on the occurrence of other billfish in the Mediterranean since we know little of this area from the standpoint of Istiophoridae. There are numerous records in the literature of billfish occurring in the Mediterranean. Most of these have been called Tetrapturus belone, the spearfish, however, in several cases we have found them to be white marlin and in one publication, a blue marlin caught off Portugal was called T. belone. This last summer we worked the Mediterranean coast from the Straits of Gibraltar to Genoa, Italy and made arrangements with freezing companies to obtain specimens for us and hold them till next summer when Col. Howard plans to return. At that time he is planning to expand this program to southern Italy and Sicily, where numerous Tetrapturus have been reported. The general picture we found was that most, if not all, the billfish caught along the Spanish coast are white marlin. Most are caught in August and September in the area of the Straits of Gibraltar, more being caught on the African coast than on the Spanish side. There seems to be a general trend to decreasing numbers as one travels east and north from Gibraltar.

Our sources of information were primarily the fishermen who operate the tuna trap fishery of Spain and those who fish commercially for swordfish with a modified long line. The tuna trap fishery is in itself of considerable interest and is one of the oldest existing fisheries in the world. Its origin has been lost with the passing of time but most certainly goes back hundreds and perhaps thousands of years. The catching of tunas by some method is indicated from early historic times by the finding of ancient Grecian coins and pottery bearing the facsimile of a tuna.

I examined 3 specimens of Mediterranean spearfish in a museum at Genoa, Italy. These were old specimens in rather bad shape, but they differ in two important ways from our western Atlantic specimens. In fish of comparable size the bill and pectoral fin both are considerably shorter than in our species. These characters should be little changed even in poorly mounted specimens but a final conclusion will have to await examination of fresh specimens which Col. Howard hopes to obtain next summer. I also examined the type of Tetrapturus lessonae which was caught in the Bay of Genoa, and agree fully with Prof. Tortonese that it is a white marlin.

Conclusion

Having gone from world records in New Zealand to dusty museum specimens in Italy, I would like to conclude by relating an interesting occurrence which happened between trips last year off the Florida Keys. In the early part of July, we had several weeks of calm water. One day during this time I went out along the inner edge of the Gulf Stream.

On this particular day there was very little floating weed and what there was consisted of short sprigs of bleached white manatee grass concentrated along the edge of a current eddy about a half mile off the reef. Among this weed were numerous small fish. Upon dipping up several of these, a very small sailfish was found. Several hours dipping produced 4 more, as well as numerous small jacks, dolphin, flying fish, etc. The largest of these sailfish was less than an inch and a half long. This fish remained alive for about 6 hours in a bucket of sea water but during the whole time continued to swim straight down with its bill against the bottom of the bucket.

For several days thereafter numerous small billfish were taken from the stomachs of tunas and bonito and large schools of frigate mackerel were seen feeding on these fish concentrated along the current edge. This is somewhat of an about-turn since small tunas and frigate mackerel form a good part of the diet of adult billfish.

Those of you who have followed the Game Fish Conference over the past five years have undoubtedly noticed that considerable effort has been devoted to billfish research by various institutions and individuals. Thru such effort much has been added to our knowledge of these fishes but you have also probably noticed that with every advance new problems likewise become apparent. Thus it would not be surprising if new advances in our knowledge of billfish should be the topic of talks at the Game Fish Conference for a good many years to come.

TABLE I

Species	Wt.	Sex	Stomach Contents
Striped	228	F	1 small squid, about 500 cc small fish bones, 6 small unidentified fish.
"	161	F	Stomach unexamined.
"	227	M	15 small fish including 2 Trachurus 12" T.L.
"	237	M	Stomach unexamined.
"	229	F	2 Mackerel (Scomber).
"	165	M	1 small Mackerel (Pneumatophorus) 12" T.L.
"	205	M	1 Schnapper (Chrysophrys auratus) about 16" T.L., 1 squid about 10" T.L.
"	331	F	6 pink Maomao (Caprodon longimannus) about 16" T.L., 1 Schnapper about 16" T.L., 1 small squid, 1 clupeid, 1 unidentified fish about 10" T.L.
"	215	M	1 Schnapper about 17" T.L., remains of small fishes.
"	269	F	Stomach everted.
"	276	F	3 mackerel skulls, 1 unidentified backbone about 12" long.
"	248	F	Stomach empty.
"	179	F	1 pink maomao about 15" T.L., 1 puffer about 4" T.L.
"	363	F	Kahawai about 18" T.L. (bait?).
Blue	411	F	Stomach empty.
"	462	F	Stomach empty.
Black	700	F	4 pink maomao about 16" T.L., 2 Schnapper about 16" T.L., numerous small bones (Mostly schnapper).
Black	354	M	4 pink maomao about 14-16" T.L., 1 Trevally about 18" T.L., 1 Schnapper skull. 8 small unidentified fish about 10" T.L.

TABLE I

Species	No.	Sex	Stomach contents
Scylpea	213	F	1 small squid, about 500 cc small fish bones.
"	218	F	8 small unidentified fish.
"	217	F	Stomach unexamined.
"	212	M	19 small fish including 2 Trachurus 12" T.L.
"	214	M	Stomach unexamined.
"	215	F	2 Hackeyi (Scombr)
"	193	M	1 small Mackerel (Thunnathophorus) 12" T.L.
"	202	M	1 Schnapper (Chrysophrys auratus) about 16" T.L.
"	217	F	4 pink Maomao (Cheilodon longimanus) about 18" T.L., 1 Schnapper about 10" T.L., 1 unidentified fish about 10".
"	213	M	1 Schnapper about 17" T.L., remains of small fishes.
"	209	F	Stomach everted.
"	219	F	2 Mackerel sharks, 2 unidentified backbone about 12" long.
"	248	F	Stomach empty.
"	119	F	1 pink maomao about 15" T.L., 1 puffer about 4" T.L.
"	363	F	Kahawai about 18" T.L. (bait).
Blue	411	F	Stomach empty.
"	462	F	Stomach empty.
Black	700	F	4 pink maomao about 16" T.L., 2 Schnapper about 16" T.L., numerous small bones (Mostly schnapper).
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A PRELIMINARY STUDY OF THE SPORTFISHERY IN BISCAYNE BAY, FLORIDA

presented by

Richard A. Wade

THE MARINE LABORATORY
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by Richard A. Wade

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The purpose of this work is to acquire first-hand information about the kinds of fish in the Bay--together with their habits and movements.

Several controversies have centered on Biscayne Bay, especially on the southern part.

FIRST--Bulkhead lines are being changed on the outer islands and more changes are being considered such as the proposal to fill in many acres of land west of Mashta Island.

SECOND--Some areas of the bay are fished with roller trawls by the live-bait shrimp industry.

THIRD--The area is a center of activity for boating, water skiing, and sports fishing.

Bulkheading and other shallow-water habitat changes are heartily condemned by some fishing clubs and conservation organizations. The bait-shrimp fishery is often criticized by these clubs, also.

It is difficult to make reasonable decisions concerning the effect of these activities on sports fishing because we don't have sufficient information on the gamefish species that are present--their life histories, and the conditions under which they will flourish or perish.

Answers to these fundamental questions must be found before any work can be done on population dynamics.

Coast Guard Chart 848 shows a large portion of Biscayne Bay in detail. The bay separates the mainland of Dade County from the offshore chain of islands beginning with Miami Beach in the North and extending to Key Largo (N. end) by way of Fisher Island, Virginia Key, Key Biscayne, etc.

Lets look at some of the sportsfishing action in the Bay. Film.

Now that we have made a pictorial tour of Biscayne Bay by land, sea, and air, let's go back and gather more information about this area:

The geography of the mainland runs in a NNE direction, the open string of islands from Miami Beach to Key Largo runs in a NS direction, these together suggest the legs of a large "A", the bay area being inside this "A".

Biscayne Bay is fed by six small fresh water rivers and canals from the mainland and the ocean tide from the Atlantic Ocean:

These six canals starting from the north are:

1. Arch Canal - near Bakers Haulover.

2. Biscayne Canal - entering the bay above the 79th Street Causeway.

3. Little River Canal - entering the bay below the 79th Street Causeway.

4. Miami River - which empties into the bay near downtown Miami and has more flow than all the others combined.

5. Coral Gables Canal.

6. Snapper Creek.

All six of these tributaries have their source in the Everglades, and come down to the bay laden with organic matter, and all six rivers together bring in fresh water amounting to 1/10 the amount of sea water during one tidal cycle.

The bay has several causeways and bridges, from north to south they are:

1. 123 Street Causeway leading to Bal Harbour.

2. 79 Street Causeway leading to North Bay Village and Normandy Isle.

3. Julia Tuttle Causeway from N.E. 36 Street to Miami Beach.

4. Venetian Causeway from N.E. 15 Street to the Beach.

5. McArthur Causeway from N.E. 13 to the southern part of the Beach.

6. Rickenbacker Causeway from S.E. 26 Road to Virginia Key, and Key Biscayne.

Biscayne Bay is nearly 20 miles long by about 2 1/2 miles wide

throughout most of its length. At the apex of the "A" there is a narrow channel connecting it to the body of water above the Intracoastal Waterway. The bay is open at its apex at Bakers Haulover. Near the bottom of the "A", the bay is open to the ocean at Government Cut. Below this area the bay is open to the ocean at Norris Cut, Bear Cut, and south of Key Biscayne. Tidal waters enter thru these cuts. The south end of the "A", the open end, is separated from the ocean by a long series of shallow flats which are separated by many deep channels between the ocean and the bay.

Tidal Flow

In general, when the tide is rising, current flows in thru Bakers Haulover south to a point north of the 79th Street Causeway. At the same time the tide enters Government Cut and Norris Cut and flows both north to beyond the 79th Street Causeway and south to above the Coconut Grove area. Water entering the bay thru Bear Cut and below Key Biscayne flows towards the Coconut Grove area.

During the fall of the ebb tide the current reverses from these areas and the flow is mainly dependent upon the direction and velocity of the wind. From May to October, the prevailing winds are south and southeasterly, during the winter season they are north to northeasterly.

Tide flow in and out of the bay is obstructed by numerous islands. There are nearly 50 inhabited natural and man-made islands! Also, there are nearly as many sand bars and uninhabited islands. These islands cause the current flow to be decreased, obstructed and diverted from the natural tide flow. Note: the Florida Current is close to the Miami shore and there is an inverse correlation between mean sea level - Miami, and the mean speed of the Florida Current.

Depth

The bay is quite shallow over most of its area, averaging less than 6 feet over the north and central areas, with many areas less than 3 feet. The southern portion is deeper at the middle of the bay and averages from 8 to 10 feet in most places.

Bottom Sediments

The sediments of the bay consist of oozes and muck with various fractions of sand, silt and clay. Any materials larger than sand occurs in the form of eroded limestone, dead shells and corals. Tropical storms or the occurrence of strong and steady onshore winds whip up these sediments which may cause fish-kills by clogging the gill chambers.

Temperature

Surface temperatures in Biscayne Bay generally range between 18 and 32°C. Temperatures off Hurricane Harbor, Key Biscayne have descended to a minimum of 15.6°C. Serious fluctuation in temperature can alter the species composition of fish found in the bay. The winter of 1957-58 proved this - many of our common game fishes (mutton snapper, and panfish bluestriped, white, and French grunts) were killed in large numbers by the freeze and disappeared from the local catches. Northern species as pigfish moved in and became dominant for a while. Now, following two warm winters, the tropical species are back. Details are not available on these fish kills!

Salinity

Biscayne Bay is estuarine in nature, and the daily and seasonal variations in salinities are subject to fluctuations resulting from the interaction of fresh water discharges, wind and tidal currents, and nearness to the Gulf Stream.

Example: The salinity increases from some 5 ppm (parts per mille) in the mouth of the Miami River to higher than 36 ppm west of Soldier Key. It is also interesting to note that the salinity at a given station may range 10 to 12 ppm during a tidal cycle. Note: there is a marked decrease in bay salinity with the beginning of the summer rainy season.

It has been stated that in the southern half of the bay along the western shores near Tahiti Beach the character of the water does not change during a tidal cycle. In the southern part of the bay between Biscayne Channel and Featherbed Bank mixing is believed to take place rapidly and the characteristics of the water in this area are similar to those of the ocean. Because of the over-all shallowness of Biscayne Bay, a two layer estuarine system exists mainly in the several channels which average 30 feet in depth.

Transparency

The water in Biscayne Bay is much less transparent than the offshore oceanic water. While the turbidity of offshore oceanic water is due mainly to planktonic organisms, the inshore and bay water turbidity is due to small plankters, together with easily disturbed bottom sediments. In addition the bay waters, especially in the harbor areas, exhibit yellow-brown colors due mainly to dark waters from the canals and rivers.

It is hoped to study these physical factors in greater detail correlating them with chemical and biological phenomena.

Dade county has built two catwalks on the Rickenbacker Causeway Bridges at a cost of $186,000 to accomodate the sportsfisherman. One of these is found at the second bridge named earlier as the drawbridge, the other is located at the third bridge also known as the Bear Cut Bridge. In addition there is Crandon Park Marina which is adjacent to Bear Cut. This is the site of hundreds of boat launchings every week - year round!

Because of the lack of sufficient funds at the present time work has been carried on in a somewhat limited basis. The catwalks on the above mentioned bridges are fished intensely, therefore they serve as the prime area for coverage at the present time until an expanded program can be put into effect covering other areas of the bay.

Direct observations are made from these bridges at different tides and at various hours of the day and night. Physical data including water temperature, sea and weather conditions are noted together with notes on fishing pressure.

All catches inspected are identified and measured. Notes on the gonad condition and stomach contents are made. (Parasites are collected and preserved for future study) It was estimated that approximately 120 different kinds of fish would be recorded from these two bridges - to date there has already occured about 70 species, 26 of which can be considered as marine game fish including the bonefish, bluefish, barracuda, mackerels (3 sp.) snook, groupers and snappers, etc.

An important phase of the study of the sportsfishery of Biscayne Bay carried on thru the bridge fishing survey concerns the arrival and departure of seasonal fishes such as the bluefish and mackerels - checks will be made to see if such movements are correlated with observed hydrographic conditions.

The cooperation of the fishermen has been excellent and none have refused to allow their catch to be examined and measured. It is hoped at the proper time to publicize this program, enlisting the aid of all concerned with sportsfishing in the Biscayne Bay area. As it is true for any wildlife program, the cooperation of the scientist and sportsman is necessary for conservation policies beneficial to all.

PROPOSED BOOK ON MARINE FISHES OF THE WEST INDIES

presented by

John E. Randall

THE MARINE LABORATORY
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In November, 1958, The Marine Laboratory of the University of Miami began its marine biological--fisheries survey of the Virgin Islands National Park on St. John, Virgin Islands, with the support of the Dingell-Johnson program of the U. S. Fish and Wildlife Service and the National Science Foundation. At this time the director of the National Park Service, Conrad Wirth, asked the author if it would be possible to prepare a guide book to the common fishes of the Virgin Islands. Shortly thereafter work began on this book with the collection, identification, and photography of St. John fishes. The more colorful species were photographed in color and the drab ones in black-and-white. At the time of this writing nearly 200 fishes have been photographed, roughly half in color and half in black-and-white, in a manner suitable for publication. A short paper has been completed describing the technique used to photograph these fishes (in press, Copeia).

Since all of the fishes found in Virgin Island waters can be expected to occur elsewhere in the West Indies and a majority of the West Indian fishes are found in the Virgin Islands, it was decided that a more comprehensive volume dealing with the inshore and epipelagic fishes of the entire West Indian region could be attempted following the completion of the Virgin Islands guide book. This second volume will be co-authored with C. Richard Robins.

The formats of the two books will be similar, and plates from the first will be used for the second, as well as species accounts with modifications. In the introduction the scope of the work will be given, ichthyological nomenclature will be explained with diagrams, a historical account of ichthyological contributions in the region will be presented, and zoogeography will be discussed. Each family of fishes will be discussed in general terms. Each species account will be headed by scientific name and author and common name. The text of the account will be divided under a maximum of three headings: Diagnosis, Biology, and Remarks. The diagnosis section will include the counts of fin rays, scales, and gill rakers, the salient characteristics by which the species can be identified, and any marked differences in color or morphology with sex or age. The biology section will summarize what is known of the habitat, food habits, spawning season, size, etc. Under remarks such things as range, relative abundance, whether of commercial or sportfishing value, how caught, and whether poisonous, venemous, or otherwise dangerous to man will be discussed.

The quarterly and annual reports and scientific papers that have been and will be written as a result of the research program in the Virgin

Islands rarely reach the layman for whom the survey is primarily intended. On the other hand, a guide book which not only provides ready identification of the fishes but summarizes the results of the ecological investigations would be an ideal end product for the three year program.

Before the West Indian volume can be begun in earnest, collections of fishes (and photographs of species not previously procured) will have to be made at many localities throughout the West Indies for which no study material is now available at The Marine Laboratory.

It is hoped that most of the colorful West Indian fishes can be illustrated in color, as they so richly deserve. The high cost of color printing, however, is a major obstacle to the completion of these volumes. Publication in color would not be possible through the Government Printing Office, for only black-and-white illustrations are permitted. In May, 1960 a request for an appropriation for color printing was made to the Virgin Islands government but did not pass the legislature. Support for color reproduction is still being sought.

TAGGING STUDIES ON BARRACUDA IN THE FLORIDA KEYS

presented by

Victor G. Springer and Andrew J. McErlean

FLORIDA STATE BOARD OF CONSERVATION
Marine Laboratory, St. Petersburg

at the Fifth

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by Victor G. Springer and Andrew J. McErlean

Florida State Board of Conservation
Marine Laboratory, St. Petersburg

ABSTRACT

The Florida State Board of Conservation barracuda tagging program commenced March 1960. Almost all tagging has occurred off Key Largo, Florida Keys. To date (November 1960) 423 barracuda have been tagged, 100 with darts and the remainder with Petersen disc tags. Tagging with darts has been discontinued because of unsatisfactory results (three returns, all recaptured by us). It is suspected also that Petersen tags are inefficient when used on barracuda (15 returns, three recaptured by us). Returns indicated no significant movement on 13 fish at large 4 to 74 days and a net movement of 4 to 20 miles on five fish at large 6 to 48 days. Studies are continuing.

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THE CHALLENGE OF MARINE GAME FISH RESEARCH

presented by

Lionel A. Walford

BUREAU OF SPORT FISHERIES AND WILDLIFE
Fish and Wildlife Service

at the Fifth

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THE CHALLENGE OF MARINE GAME FISH RESEARCH

by Lionel A. Walford

Bureau of Sport Fisheries and Wildlife
Fish and Wildlife Service

ABSTRACT

The Bureau of Sport Fisheries and Wildlife has been given the tast of undertaking a comprehensive program of research concerning marine migratory game fishes. In formulating this program, the Bureau must examine these questions: What makes a fish a "game" species? What are the most important species so categorized? What kinds of research might lead to the most valuable results? How can the program of the Federal Government fit in best with those of other agencies engaged in marine research and how can it best serve the general public?

The research program will be initiated at a newly established laboratory located on Sandy Hook, New Jersey. Full facilities will be available at this laboratory for resident and visiting scientists. (Illustrated with slides).

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IMPORTANCE OF BEHAVIOR RESEARCH TO UNDERSTANDING THE BIOLOGY OF GAME FISHES

presented by

Warren J. Wisby

THE MARINE LABORATORY
University of Miami

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IMPORTANCE OF BEHAVIOR RESEARCH TO UNDERSTANDING THE BIOLOGY OF GAME FISHES

by Warren J. Wisby

The Marine Laboratory, University of Miami

The objective study of animal behavior has been pursued by two major schools, the comparative psychologists and the comparative ethologists. The psychologists have mainly concentrated on studying learned behavior and mechanisms of learning, perhaps because of their interest in understanding human behavior from studying the behavior of lower forms. The ethologists, on the other hand, have generally emphasized "innate" (e.g., phylogenerically adapted) behavior in their studies. While the approaches are different, both kinds of information are important to an understanding of the total behavior of an animal.

The following summary of our present knowledge of fish behavior is, of necessity, very brief. In some cases this has resulted in over-simplification, as well as in omission of certain minor details. It is hoped that it will serve mainly to refresh the memory of interested persons and will not be considered a reference work in itself.

The evidence gathered from experiments on bony fishes indicates that phylogenetically adapted perceptual and motor patterns, which are essentially the same in all of the members of a species, play a particularly large role in fishes. In order for a particular behavior pattern to be produced, the fish must be in the proper physiological state while being exposed to the appropriate "Key stimulus". The resulting activity may then be guided by other stimuli originating in the internal or external environment, or the Key, or releasing, stimulus itself may serve to orient the movements.

In its most simple form, a releasing, or Key, stimulus can be thought of as the finger which presses the trigger of a gun, and thereby elicits an activity which, until then, had existed merely as an internal potential. Its action has also been described (Lorenz, 1950) as being similar to that of a filter, permitting only those stimuli to penetrate which activate the responses. Releasing mechanisms do not always respond to simple "sign" stimuli, however. Several factors have been shown to be responsible for the plasticity evident even in behavior patterns which are thought to be entirely innate, and some of this plasticity may be dependant upon properties of the releasing situation. The intensity, or direction, of the movements may vary with the amount of information received by a sense organ from the releasing situation, with the number of sensory channels involved, and/or with changes in the intensity of the internal motivation of the animal. Also, the IRM (innate releasing mechanism) is the very point at which conditioning takes place.

Three major levels of organization of these innate movements have been described (Tinbergen, 1950): the drive, the appetitive behavior,

and the consummatory act. They are, generally, easier to detect in the more complex activities of fishes, such as spawning, which may consist of a series of these sequences, than in some simple activities which may be composed of only one.

The concept of "drive" has been discussed by Thorpe (1951) and Baerends (1957) and has been defined as, "the complex of internal and external states and stimuli leading to a given behavior". It differs only slightly from the concept of "specific action potential" (Thorpe, 1951; Hinde, 1954) which consists, simply, of those conditions in the animal which favor the occurrence of a particular behavior pattern over any other. "Drive" may result in increased locomotary activity, and this more flexible and adaptable phase has been called "appetitive behavior". The "consummatory act" is the most rigid of the behavioral components and it occurs when the appropriate releaser stimulus is encountered.

The normal and orderly sequence of movements, as described above, may be changed or interrupted under certain circumstances, and the resulting activity (Displacement Behavior, Fallback) may give the impression of being completely inappropriate in the situation in which it is produced. These movements, and the conditions which give rise to their production, have been discussed by Tinbergen (1951, 1953), Baerends (1957), and van Iersel (1953) who conclude that the behavior, although inappropriate, is predictable.

Several types of natural learning have been found in fish (Thorpe, 1956), and their behavior is probably modified and rendered more plastic by means of these phenomena. "Habituation" is one which is commonly observed, and means simply that fish learn not to respond to stimuli which have no significance for them (Hinde, 1954). Simple conditioned responses also occur commonly in nature and are responsible for much of the plasticity and adaptability of the natural behavior of fishes.

Aronson (1951) has presented evidence that the phenomena called "insight" and "latent learning", which are considered by some to be equal and inseparable (Maier and Schneirla, 1935; Thorpe, 1950), may be important in the lives of certain fishes. He found that Bathygobius soporator, in swimming over the bottom, learned the bottom details so well that, at low tide, it was able to jump from one pool to the next over the intervening obstacles and only rarely made a mistake. The spatial relationships of its environment were learned so well that it was able to respond in an appropriate manner to a potentially dangerous situation at a later time and under different conditions.

"Imprinting" is also considered to be a type of learning (Lorenz, 1935, 1937) and has been reported in fish (Noble and Curtis, 1939; Baerends and Baerends-van Roon, 1950). In this case, a single

exposure to a stimulus at a particular time in the animal's life may cause a permanent change in behavior. Hoar (1958) describes an example in young pink salmon, where the usual behavior of hiding under rocks at high light intensities changes at their first experience with schooling, after which they remain in the school rather than hide in the gravel.

Simple forms of "trial and error" learning may occur in nature, but there is, at present, no concrete evidence for this (Hoar, 1958.) It has, however, been used as a laboratory technique in investigations of fish behavior, and has been used with sharks by Eugenie Clark (1959.)

NOTES ON THE BIOLOGY OF THE BONEFISH AND ITS SPORTS FISHERY IN PUERTO RICO

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Donald S. Erdman

DINGELL-JOHNSON FISHERY BIOLOGIST
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NOTES ON THE BIOLOGY OF THE SOUTHERN
AND ITS SPORTS FISHERY IN PUERTO RICO

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NOTES ON THE BIOLOGY OF THE BONEFISH AND ITS SPORTS FISHERY IN PUERTO RICO[1]

by Donald S. Erdman

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ABSTRACT

This study was undertaken to determine the relative abundance and availability of the bonefish or "macaco" in Puerto Rican waters for sport fishermen. The average size of 446 bonefish which were measured and weighed was less than 1 1/2 lbs. The most prevalent food item in the stomachs and intestines of 303 bonefish examined was a small white clam, Codakia costata, about 1/2 inch in diameter. From study of gonad development, the peak of the spawning season seemed to run from November to January.

Bonefish were most abundant on the flats in May, and were most available on shallow sand bottom behind windward offshore coral reefs. Leptocephalus bonefish larvae were collected with a light on moonless nights every month in the year except July; they were most abundant from March to May and scarce in October and November.

Introduction: Both local and visiting sport fishermen have shown interest in the status of the bonefish in Puerto Rico. With the concern of sport fishermen in mind, this study was undertaken to determine the relative abundance and availability of bonefish in Puerto Rican waters. The investigation started in July 1958, and the present phase of the study terminated on June 30, 1960.

Methods: Adult bonefish were collected for study of spawning condition and food habits by use of gill and trammel nets usually set on moonless nights in the vicinity of La Parguera. Young leptocephalus larvae were collected on moonless nights with a dip net while nightlighting.

Reef flats known to be frequented by bonefish were searched at regular intervals with spinning tackle at La Parguera and during three visits to Culebra Island. A school of over one dozen bonefish

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[1] This study was conducted by the Fish and Wildlife Section of Puerto Rico in conjunction with Federal Aid in Fisheries, Dingell-Johnson Project, F-1-R-7.

was seen "tailing" the reef shallows of Punta Colorada, east coast of Culebra, in the late afternoon of May 7, 1959; and a single bonefish was seen on May 6, 1959 off Pelaita Cay, Mangrove Harbor, Culebra. No bonefish were seen on the same Culebra reefs during 6 days from November 11-16, 1959, when only four were caught in nets at night. No bonefish have been seen by the writer on over 30 separate days during daytime on the Parguera reefs, where bonefish have been caught at night.

No bonefish were seen at Pajaro Beach, Mona Island, on March 20 and 21, 1960, though bar jacks were abundant; and none were seen at Sardinera and Isabela, Mona Island, during May 15-21, 1960. Six leptocephalus bonefish larvae were collected at Sardinera on the night of May 17.

Areas of Occurrence: While bonefish is somewhat ubiquitous as a species in Puerto Rican waters, areas where it is most likely to be found in numbers are listed in order of importance as follows: 1. Culebra, east coast, Punta Colorada to Mangrove Harbor; 2. Vieques, south coast, Red Beach; 3. Vieques, north coast east end; 4. La Parguera, eastern reefs such as Romero and Enmedio (Corral); 5. Los Morrillos, Cabo Rojo Lighthouse; 6. Boqueron, Cayo Fanduco; 7. Bramadero Bay south of Mayaguez; 8. East side Cabros Island opposite San Juan; 9. Mameyes River to Luquillo Beach.

In the U. S. Virgin Islands, perhaps the south coast of St. Croix with its shallow reefs is best, especially Krause Lagoon. At St. John, Leinster Bay on the north coast, and Reef and Fish Bays on the south coast have occasional bonefish. Bonefish are rare at St. Thomas but have been caught at Water Isle and Benner Bay. The south coast of Anegada in the British Virgin Islands should have possibilities for bonefish because of its extensive sand and coral shallows.

Preferred Habitat: A glance at chart #920 of Puerto Rico shows that the shoal water is small. Of this limited shoal water, a few areas are suitable for bonefish; and only a small number of reefs can be said to be frequented by bonefish on occasion. Preferred habitat seems to consist of shallow sand bottom mixed with patches of Porites coral behind windward offshore reefs with some deep water between the reef and the mainland. Better reefs are in a windward position to neighboring reefs, as occurs at Punta Colorada, Culebra, and at Romero and Enmedio reefs at La Parguera.

Food Habits: Small white clams less than one inch in diameter occurred in more than 40% of the 303 bonefish examined (see Fig. 1). The most prevalent clam species was Codakia costata. Small crabs occurred in about 30% of the stomachs; the most frequent species was Cronius tumidulus (see Table 1). There seemed to be a positive correlation between the relative abundance of shrimp in bonefish stomachs and the actual abundance of bonefish; 23 out of 55 bonefish examined from Mangrove Harbor, Culebra

on January 10, 1959 had one or more shrimps, whereas the overall average frequency of shrimp in bonefish is barely 10%. Smaller bonefish apparently did not eat fishes; and only four larger bonefish ate fishes as follows:

Bonefish ♀ 7 3/8 lbs. Jan. 26/60 3 parrotfish and 2 grunts

" 4 1/4 ♂ lbs. Jan. 10/59 1 goby

" 8 1/4 ♀ lbs. May 12/60 1 filefish and 2 eels

" 7 1/2 ♀ lbs. May 12/60 1 filefish and 3 eels

At La Parguera, bonefish caught from the leeward reefs contained more snails and less clams than bonefish from windward reefs. The leeward reefs usually have fewer and smaller bonefish; and it would appear that snails may have been a second choice compared with clams. The more abundant snails in bonefish are Turbo opercula. The situation at Culebra in regard to food habits was most similar to the windward reefs at La Parguera as follows:

no. of bonefish	locality	bonefish containing snails	clams	crabs	shrimp
104	Culebra	0	60	38	25
163	windward reefs, Parguera	3	85	66	10
33	leeward reefs, Parguera	14	7	11	0
300		17	152	115	35

From the leeward reefs at La Parguera, such as La Conserva and El Palo, 42% of the bonefish caught from those reefs had snails, only 21% had clams, and none had shrimp. From the windward reefs, such as Romero and Enmedio, only 2% had snails; over 50% had clams; and 10% had shrimps. Crabs on the other hand occurred in about 30% of the bonefishes from all areas.

Average Size: The average weight of 446 bonefish was about 1 1/4 lbs. The most abundant weight class 1-1 1/2 lbs. had 141 fish. The weight class from 1 1/2 to 2 lbs. had 110 fishes; over 50% of the fish weighed between 1 and 2 lbs. The smallest young adult was 7" fork length and weighed about 4 oz. The largest was a female 10 1/4 lbs. caught from Romero Reef on June 7, 1960. Average length-weight relationships for bonefish are given in Table II.

Spawning Period: Ripe male and near ripe female bonefish have been found by the writer only in the months of November, December, and January in Puerto Rico. The greatest number of ripe fish were examined during January. Since samplings observed during February contained

mostly immature fish less than 1 1/2 lbs., it is possible that fish in spawning condition will be found in February.

Females, considered as ripe, had large ovaries with well formed yellow eggs slightly less than one millimeter in diameter. Several males had ripe milt which could be easily pressed out of the genital pore. The smallest near ripe male weighed 2 1/4 lbs.; and the smallest female with developing eggs weighed 3 lbs. All males examined weighed less than 5 1/2 lbs. There was no consistent difference in length-weight ratio between the sexes in the same size group. Relative heaviness to length depended on the extent of development of the gonads. Females apparently grow larger, since all bonefish of 5 1/2 lbs. or more were females. In general, most bonefish were found in good condition, and many had fat bodies.

Seasonal Abundance of Adults: Bonefish seemed most abundant on the reef shallows in May. On May 7, 1959, 12 were caught in a set of only 200 feet of gill net at Punta Colorada, Culebra; whereas, only 4 were caught with the same amount of gear fishing in the same general area on 6 nights from November 11-16, 1959. On May 25, 1960, the largest single catch during this investigation was made with a single set of a 90 fathom net at Enrique Cay, La Parguera, at sunset.

Commercial fishermen at La Parguera say that bonefish become more abundant on the flats at the beginning of the cooler weather in November, a characteristic which has not yet been observed by the writer during this investigation.

Bonefish proved to be abundant at Culebra in August 1958, and January and May 1959. They were abundant on the windward reefs at La Parguera in May 1960.

Bonefish are most apt to be seen at low tide when the tide is starting to come in, as was the case at Punta Colorada on May 7, 1959. They also show activity at sunset, which was indicated at Enrique Cay on May 25, 1960.

Seasonal Abundance of Leptocephalus Larvae: Leptocephalus larvae of bonefish are transparent tape-like fishes around 2 inches in length, which can be caught nearly the year around in shallow water behind reefs at La Parguera. The writer has caught them at night every month in the year except July. They are most abundant from March to May, especially in May the month of adult abundance. They are scarce in October and November, and apparently absent in July.

The writer has caught leptocephali which were metamorphosing to the adult form at Luquillo Beach on June 3, 1945. The fish were caught with a minnow seine in moderate surf on sand bottom near the water's edge. Six were collected: 2 leptocephali 2 1/8" Standard Length;

2 late metamorphic larvae 1 1/8" which had the appearance of adult bonefish but were flat and transparent; and 2 small bonefish with adult form and coloring 2 1/8" S. L.

Though the writer has not collected any more leptocephali in metamorphosis, it is possible that the apparent absence of leptocephali in July may be due to metamorphosis on a large scale during June. Over 100 leptocephali have been collected from 45 to 64 mm. in standard length. The larger ones seem more fully developed. The duration of the leptocephalus stage is estimated to be 5 to 6 months from the egg to the young adult form on the basis of peak spawning in January, metamorphosis in June, and apparent absence of leptocephalus in July.

Most of the collections of leptocephalus bonefish larvae were made at El Nacillo reef, just south of the town of La Parguera. A total of 44 collecting trips were made on different nights throughout the months of the year. The number collected were recorded, and the number seen were estimated. The average trip is estimated at a half hour's duration for convenience, though the true average time was closer to 40 minutes:

Catch rate of leptocephalus bonefish larvae with night light, mostly from La Parguera, Puerto Rico, by month.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
no. trips	3	4	4	2	4	3	3	8	1	5	6	1
no. caught per trip	7	21	30	9	18	6	-	13	3	3	7	19
no. seen	14	25	60	9	100+	6	-	20	3	3	10	50
est. no. seen per hr.	9	12	15	5	25+	2	-	3	3	1/2	2	50

During growth, the bonefish changes its foods and habitats which has been indicated in the following manner from this study:

Habits during the development of bonefish:

1. Egg about 1 millimeter in diameter.

2. Pelagic leptocephalus stage of larvae for an unverified time, but 5 to 6 months are estimated on basis of spawning time and time of metamorphosis.

3. Leptocephalus stage in shallow protected areas behind reefs, from 45 to 64 mm.

4. Leptocephalus in metamorphosis to young bonefish during June along shore in moderate surf on sand bottom.

5. Young bonefish from four ounces to 12 ounces or more live over mud bottom in mangrove areas near shore.

6. Bonefish averaging one pound tend to congregate on leeward reefs at La Parguera and feed largely on snails.

7. Bonefish averaging more than 1 1/4 pounds to 10 pounds feed mostly on clams, and occasional fish when from 4 to 10 pounds.

Commercial fishery: The extent of the commercial fishery in respect to bonefish at La Parguera is apparently minor. Bonefish are not sought because they bring a low price. Occasional sport fishermen buy them for marlin bait.

Bonefish were caught only incidentally to the catch of other fishes. From commercial gill net catches made on 18 different dates between July 8 and September 19, 1959 off La Parguera, the total catch consisted of about 1,150 lbs. of fishes; included were 35 bonefish weighing a total of 24 lbs. The majority of fishes consisted of bar jack Caranx ruber (over 600 lbs), false albacore (240 lbs), grunts, small snappers, and other fishes. Bonefish composed less than 2% of the total catch by weight, and even less by number.

Even when special gill net sets were made for bonefish on five different nights during the same period to study stomach contents other fishes predominated in the catch. A total of 27 bonefish were caught weighing 28 lbs. and 94 lbs. of other fishes, including grunts, snappers, porgies, mojarras, and needlefish.

Conclusions: There is no established sport fishery for bonefish in Puerto Rico at the present time. Individual sport fishermen have caught bonefish on occasion. The present bonefish record from Puerto Rico is 8 lbs. 9 oz. caught from Red Beach, Vieques Island, in July 1957 by Frank Diamond.

Once a sport fisherman came to Puerto Rico with bonefishing specifically in mind. He went away disappointed in part because he had no luck, but perhaps also because he may have seen some overly optimistic advertising.

The writer believes that the abundance of bonefish in Puerto Rico is still largely controlled by natural conditions. There is almost no demand for it in the commercial fishery, and it is caught only on occasion in gill nets or seines when fishermen are fishing for other species.

The small amount of shallow sand bottom behind reefs and the nearness of the 100 fathom curve to the coast are believed to be limiting factors for bonefish abundance in Puerto Rico. The quality of habitat is adequate, but there is limited quantity. Large extensive banks such as Florida Keys, Cuba, and the Bahama Islands are lacking.

Acknowledgments: The writer is indebted to Mr. Carmelo Feliciano, of the same Fish and Wildlife Section of Puerto Rico. Mr. Faliciano found out about the abundance of bonefish off eastern Culebra, and he carried on a preliminary investigation in August 1958, when he examined 27 bonefish.

All the identifications of the molluscs found in bonefishes have been made by Mrs. Germaine L. Warmke, Curator of Molluscs of the Institute of Marine Biology, University of Puerto Rico at Mayaguez. The alga, Hormothamnion enteromorphoides, was identified by Dr. Luis R. Almodovar of the same Institute; this blue green alga is reputed to be poisonous.

The writer wishes to thank Dr. John E. Randall of the Marine Laboratory, University of Miami, for pertinent information on bonefish from the Virgin Islands and Haiti, and a good photograph of a bonefish caught from Benner Bay, St. Thomas.

The writer is indebted to various sport fishermen who have given him information on bonefish, and in particular to Mr. Frank Diamond and Mr. Harold Monroe who helped the writer search for bonefish at Romero and Corral Cays, La Parguera, on several occasions.

References:

Alexander, (Mrs.) Elizabeth C. (in press)

Feliciano, Carmelo
1958. Observaciones sobre la biologia del macaco, Albula vulpes (Linn.) en la isla de Culebra, Puerto Rico. Unpublished official report, Dept. of Agr., Santurce, P. R.

Fitch, John E.
1950. Life history notes and the early development of the bonefish, Albula vulpes (Linn.). California Fish and Game, 36 (1): 3-6, 2 figs.

Beebe, William and John Tee-Van
1928. The fishes of Port-au-Prince Bay, Haiti. Zoologica, vol. X, Number 1, New York Zoological Society.

Gehringer, Jack W.
1959. Early development and metamorphosis of the ten-pounder

Elops saurus Linnaeus. U. S. Fish and Wildlife Service, Fishery Bul. 155 Vol. 59, Washington, D. C.

Meek, Seth E. and Samuel F. Hildebrand
1923. Fishes of Panama. Part I, p. 179, Chicago Natural History Museum, Chicago, Illinois.

Rasquin, Priscilla
1955. Observations on the metamorphosis of the bonefish. Journ. Morphology, 97 (1): 77-118.

Shelton, William
1959. Bimini's big shot, Bonefish Sam. Life May 4, 1959, pp. 110, etc.

Fig. I **Pie diagram of chief food items of 303 bonefishes in percent of frequencies of occurrence.**

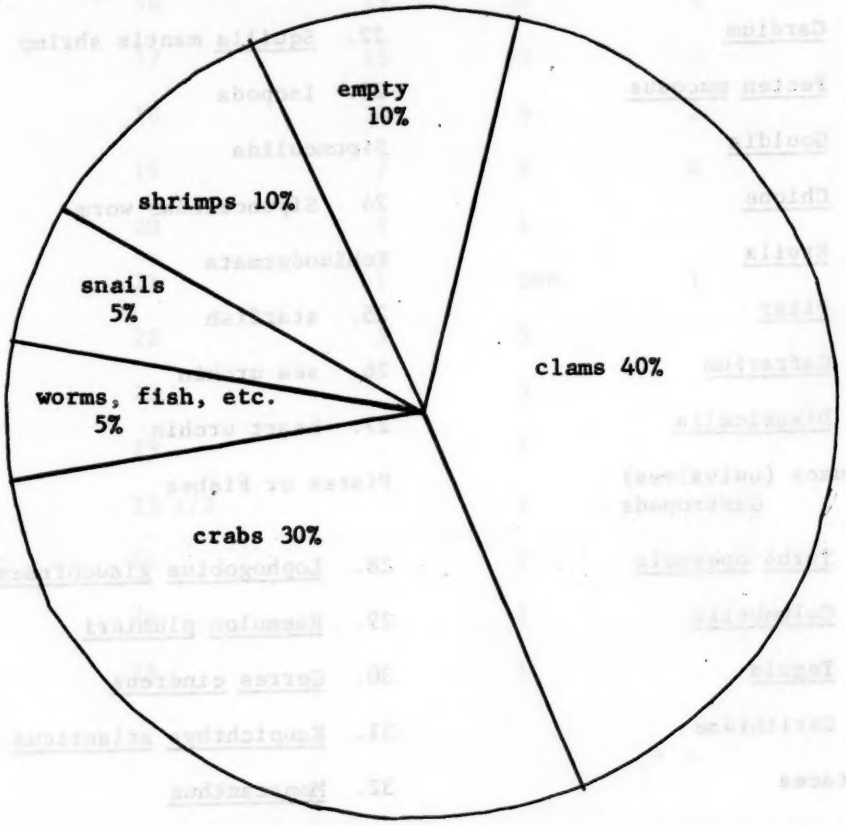

TABLE I

Annotated list of food items found in stomachs and intestines of 303 bonefishes from Puerto Rico.

Mollusca (bivalves)

1. *Codakia costata*
2. *Tellina*
3. *Laevicardium*
4. *Cardium*
5. *Pecten mucosus*
6. *Gouldia*
7. *Chione*
8. *Ervila*
9. *Pitar*
10. *Gafrarium*
11. *Divaricella*

Mollusca (univalves) Gastropods

12. *Turbo opercula*
13. *Columbella*
14. *Tegula*
15. Cerithidae

Crustacea

16. *Cronius tumidulus*
17. *Callinectes*
18. Oxystomata

Crustacea (continued)

19. *Clibanarius* hermit crab
20. Penaeidae shrimps
21. *Crangon* snapping shrimp
22. *Squilla* mantis shrimp
23. Isopoda

Sipunculida

24. Sipunculidae worm

Echinodermata

25. starfish
26. sea urchin
27. heart urchin

Pisces or Fishes

28. *Lophogobius glaucofraenum*
29. *Haemulon plumieri*
30. *Gerres cinereus*
31. *Kaupichthys atlanticus*
32. *Monacanthus*
33. *Sparisoma*

Plants

34. *Hormothamnion enteromorphoides* blue green alga
35. *Thalassia* turtle grass

TABLE II

Bonefish by frequencies in weight groups in Puerto Rico from August 1958 through June 30, 1960.

weight group	fork length*	Males	Females	Undetermined	Totals
4 to 7.9 oz.	7 inches	1?		7	8
8 oz. to 15.9	9	9	3	46	58
1 lb. -	12	48	34	59	141
1 1/2	14	58	28	24	110
2	16	19	10	6	35
2 1/2	17	15	2	2	19
3	18	14	6	2	22
3 1/2	19	7	6	4	17
4	20	5	6		12
4 1/2	21	1	5**	1	6
5	22	3	3		7
5 1/2	22		3		3
6	23		2		2
6 1/2	23 1/2		1		1
7	24		2		2
7 1/2	24		1		1
8	25		1		1
8 1/2					
9					
9 1/2					
10	28	180 m.	1/114 fem.	152	1/446

* approximate average fork lengths are given for the weight class

** a very thin female from Pirate Cay, Culebra, on June 24, 1960 measured 24 inches fork length and weighed only 4 3/4 lbs.

TABLE II

Bonefish by frequencies in weight groups in Puerto Rico from August 1938 through June 30, 1940.

Weight group	Fork length	Males	Females	Undetermined	Totals
4 to 7.9 oz.	7 inches	17	7	8	32
8 oz. to 15.9	8	9	3	16	28
1 lb.	9	44	34	24	102
1 1/2	10	58	28	24	110
2	11	24	10	6	40
2 1/2	12	12	2	1	15
3	13	10	0	0	10
3 1/2	14	6	0	0	6
4	15	5	0	0	5
4 1/2	16	1	1	0	2
5	17	3	0	0	3
5 1/2	18	0	0	0	0
6	19	0	0	0	0
6 1/2	20	1	0	0	1
7	21	0	0	0	0
7 1/2	22	0	0	0	0
8	23	0	0	0	0
8 1/2	24	0	0	0	0
9	25	0	0	0	0
9 1/2	26	0	0	0	0
10	27	0	0	0	0
		180	134	83	397

* Approximate average fork lengths are given for the weights.

** A very thin female from Piraia Bay, Cuidera, on June 26, 1940 measured 24 inches fork length and weighed only 4 3/4 lbs.

DISCUSSION

At the discretion of the editor some questions and answers have been omitted.

Chairman of the discussion session was Louis S. Mowbray, Bermuda Aquarium, Bermuda.

RESULTS OF WORK CONDUCTED BY THE MARINE LABORATORY IN 1960 IN NEW ZEALAND AND MEDITERRANEAN WATERS
Walter A. Starck, II

Robins:
Do you think you could identify the three Pacific marlins (striped, black and blue) on the basis of the pectoral fin alone?

Starck:
Yes, I do.

Capt. Parkinson:
What do the natives do with the porpoises that were in their nets (off Spain)?

Starck:
I imagine that they ate them. They killed them and they do eat porpoises in some places.

Chairman Mowbray:
Is there a sportfishery for marlin in the Mediterranean?

Starck:
No, tuna is the only large, pelagic fish that is the subject of a sport fishery.

Anonymous:
Did I understand you to say that there were no marlin in the Mediterranean?

Starck:
No. I meant that there was no sportfishery for them. There are marlin in the Mediterranean.

A PRELIMINARY STUDY OF THE SPORTFISHERY IN BISCAYNE BAY, FLORIDA
Richard A. Wade

Chairman Mowbray:
Have the seatrout in Biscayne Bay showed any increase or decline?

Wade:
I have not had an opportunity to study the movement of seatrout for any long period. Not many seatrout have been caught from the bridges.

Capt. Parkinson:
What happened to the sand perch (Diplectrum formosum, -ed.) in Biscayne Bay. They used to be very common but no longer are there in any quantity.

Wade:
I have seen very few sand perch caught off the causeway this year, this is one fish that apparently has largely bean eliminated from the Bay by changing conditions.

George Rounsefell:
Did the shrimp fishery have anything to do with the decline of the sand perch?

Wade:
No. (Ed.: On March 13, 1961, good catches of sandperch were made at the Bear Cut Bridge).

Erdman:
I think you said that there weren't many Cero. This is interesting. What was the minimum and maximum size of the Spanish and King mackerels that you are getting at the bridges?

Wade:
The Cero mackerel was more common early in the season but has now disappeared. I know this because I wanted to get pictures of the three at one time and have not been able to do so in November. Spanish mackerel run from under one foot in length to two feet in length, and the King mackerel generally run a little smaller than the Spanish mackerel and the largest ones are definitely smaller than the larger Spanish mackerel, perhaps about 18 inches.

Vic Dunaway:
Are the young King mackerel spotted?

Wade:
Yes, they are definitely spotted, perhaps more so than the Spanish mackerel.

Anonymous:
What is the largest Spanish mackerel you've seen to date in the Bay?

Wade:
Just under 23 inches in standard length (to the base of the tail).

Anonymous:
Would you say the mackerel in Biscayne Bay are stunted?

Wade:
This is one of the problems the survey aims to solve. We have not yet had a chance to study this.

Mrs. Parkinson:
May I ask about the snook in the Biscayne area?

Wade:
There are snook in the area; they run between 14-18 inches and are caught mainly at night. The "snook bridge" is the little toll gate bridge according to the fishermen. A number of snook were killed during our cold winter in the lower bay and the Upper Keys.

H. Feddern:
What types of bait do these bridge fishermen use?

Wade:
The most common bait that I found on the bridge is the pilchard. Sometimes they bring in balyhoo and use cut mullet. The mackerel seem to favor the smaller pilchards.

Walford:
What is a pilchard?

Wade:
It is a species of a Harengula and the most common one is Harengula pensacolae.

Walford:
Is the name pilchard of widespread use here?

Wade:
Yes.

Mr. Buckley:
Is there any information to suggest that the porpoises are depleating the fishing in this area.

Wade:
We have no knowledge of this and we would seriously doubt it.

McErlean:
What size barracuda do you catch in the Bay?

Wade:
We have caught very few to date, one or two a week are caught from the bridges but many more are caught by boat fishermen. The last one that we did measure from the bridge was 48 inches but they do catch them as small as 20 inches from the bridge.

Capt. Parkinson:
Do you have any tagging program on the mackerel (i.e., Scomberomorus)?

Wade:
No, not at the present time.

Robins:
The Spanish mackerel does not occur in the off-shore islands except perhaps Cuba.

Dunaway:
Are there good methods to tell the Spanish mackerel from the young King mackerel?

Wade:
In the Spanish mackerel the lateral line slopes evenly downward toward the tail. In the King mackerel the lateral line drops sharply and then continues toward the tail at a lower level. Other differences exist in the counts.

PROPOSED BOOK ON MARINE FISHES OF THE WEST INDIES
John E. Randall

Dr. Randall had other commitments and questions were answered by C. Richard Robins.

Chairman Mowbray:
Have you set any date for assembling this book?

Robins:
The main problem is obtaining photographs for the book. It takes a long time to accumulate the pictures taken for the book. Sometimes hours are spent in getting a good photograph.

W. Schmitt:
Do you propose to publish these pictures in color?

Robins:
Yes, definitely. Color is very important in identifying local reef fishes. For fishes such as barracuda black and white reproduction will suffice.

W. Schmitt:
Books published by the National Park Service included colored photographs and are very helpful. I suggest that we write people in Salt Lake City who did the National Park Service booklet work.

Robins:
Dr. Randall plans to group the pages of color plates by related species.

L. Gorham:
Do you have any pictures of the coney from St. John, Virgin Islands?

Robins:
Yes, it is one of the common reef fishes throughout the West Indies. It occurs in three basic color patterns which change back and forth. The most common is the bicolored pattern which is dark above and pale below, but it may be all brown with light blue spots. In deeper water they become bright yellow with blue spots. All are the same species.

Gorham:
Is a pure golden color with two spots on the tail a prevalent or common pattern?

Robins:
It is found in deeper water and is quite common. Capt. Bill Gray (Miami Seaquarium) has kept some yellow coneys for a long time and they have changed back to the shallow-water pattern which is the usual brown color.

Gorham:
We caught some off Elbow Cays and brought them in to have them mounted and they were a little darker but they did maintain their golden color pretty well. They were caught in deeper water, about 75 feet depth.

Robins:
The yellow-fin grouper also shows more red in the deeper waters. Of course this would not be visible at that depth.

TAGGING STUDIES ON BARRACUDA IN THE FLORIDA KEYS

Victor G. Springer and Andrew J. McErlean

Henry Feddern:
How small a fish can you tag with your Peterson disc tag?

Springer:
Our smallest recaptures have been on 450 mm fish but they can be placed on smaller ones.

Mrs. Parkinson:
Would it be of any use to you to tag barracuda off Palm Beach?

Springer:
Yes, we would like to tag barracuda everywhere. We have lacked personnel to expand the program.

Springer:
Do you know any place off Palm Beach where they are really abundant?

Capt. Parkinson:
The Wreck Buoy.

W. Schmitt:
When you recover fish at the same place do you know if the fish has moved off several miles and returned?

Springer:
No.

W. Schmitt:
You should record the hour of day that the fish is captured and released.

Springer:
We are now trying to do this.

Chairman Mowbray:
Do you have any information on the physical condition of the fish that made the long distance runs in a short time?

Springer:
We only record physical condition if the fish has been injured.

Chairman Mowbray:
I meant the condition at the time of recapture.

Springer:
No, we only have information on condition of recapture on those that we caught ourselves but not on the other fish. We were discouraged by guides when we first started tagging barracuda. They told us that barracuda once handled would not live more than a few days. However, we now know that this is not true.

Schmitt:
Did you rule out using the opercular tag?

Springer:
No we haven't ruled them out; we haven't tried them. The literature comments have been very adverse concerning the use of this tag. They do not stay on well. We haven't excluded spaghetti tags and we probably will employ that after we have tagged a sufficient number of fish with the other type.

Voss:
When you try to crimp the opercular tag, tags through the gill cover the pin takes odd turns and will not go through at a true angle.

THE CHALLENGE OF MARINE GAME FISH RESEARCH
Lionel A. Walford

Chairman Mowbray:
When do you plan or hope to complete the Atlas of Environments?

Walford:
Write in for an answer on this. I do not know off hand.

H. R. Bullis, Jr:
Is there going to be any attempt made to pick up some of the recent publications that would fit very admirably into this atlas?

Walford:
It would be perfectly in order to make a review of a series of papers and then present some sort of composite of information. However, the American Geographic Society would take a dim view of reproducing papers as such. Persons, however, can obtain working sheets from this atlas at a very nominal cost and then can mark on these sheets comments and additions.

Feddern:
Have some of these atlases been printed already?

Walford:
No, simply the work sheets.

Feddern:
When will these atlases be available for the general public?

Walford:
Well I should say next year sometime.

Mrs. Terry Robinson:
I thought you said this morning that Sandy Hook was a transitional area between the north and south. I thought that was more nearly North Carolina.

Walford:
I didn't mean to make that implication. However, northern fishes do come down beyond our place in the winter and northern fishes do come up beyond our place in summer so we are in an intermediate or at least a convenient spot in this connection.

IMPORTANCE OF BEHAVIOR RESEARCH TO UNDERSTANDING THE BIOLOGY OF GAMEFISHES
Warren J. Wisby

Robins:
Do you think that it is possible to develop a better lure for catching fish by using information gained in these studies of fish behavior?

Wisby:
Probably the most pertinent information would be that derived from studies of predatory-prey relationships. If I were to generalize, I would say that these studies have shown that the prey animal which is "out of phase" with its environment, either because of illness or being wounded or for some other reason, is the animal most likely to be attacked and eaten. It might be worth while to attempt to reproduce the movements and colors of such an animal with our baits, rather than to present a bait which is as natural as possible.

Chairman Mowbray:
You mentioned this morning the rapidity with which sharks sometimes appear around an injured fish. Has anything been done along this line of study?

Wisby:
This is an observation which has been reported by many people, and particularly by skindivers. Possibly sharks are detecting the low-frequency vibrations created by wounded or speared fishes. A program is now underway at The Marine Laboratory to investigate the detection of these vibrations by sharks. We hope, eventually, to be able to reproduce the sounds of wounded fish and to test their effect on sharks.

Erdman:
Have you done any work with the grey snapper, Lutjanus griseus? I think this animal has ability to learn and ability to remember.

Wisby:
We have not worked with this fish. One of my first impressions upon my arrival at The Marine Laboratory, however, was the adaptability and variability of the behavior of the local marine fishes, especially as compared with the freshwater fishes of the north.

Bullis:
We have noticed in our observations on sharks that a lot of them have tuna in their stomachs, some of which show no tooth marks or any bites. We then made some observations on blackfin tuna in the Caribbean and found that in the middle of the area of frenzied feeding that there were a number of sharks swimming around with their mouths wide open and we suspect that whenever a blackfin tuna got into the mouth by accident it would be swallowed.

Mrs. Parkisnon:
Would a group that did nothing more than fish for sharks be of any help to you and in what way?

Wisby:
Thank you for your implied offer of assistance. Unfortunately, our current problem is to keep them alive after capture. At the moment, we are able to get an adequate supply of sharks from The Miami Seaquarium.

NOTES ON THE BIOLOGY OF THE BONEFISH AND ITS SPORTS FISHERY IN PUERTO RICO

Donald S. Erdman

Chairman Mowbray:
What is the principal method of capture of bonefish in Puerto Rico?

Erdman:
Chiefly using flys and spinning tackle. Both Vieques and Culebra seem to be a little better for bonefish than Puerto Rico proper.

Surber:
You mentioned finding the leptocephalus of the bonefish in all months except July. Where do you find them?

Erdman:
Yes that is true; we find them along the shore but in more protected areas.

Anonymous:
How small bonefish are caught sportfishing in Puerto Rico?

Erdman:
Generally about one pound. The reason for this is that if they are less than a pound they are generally off the fishing reef or in the mangroves and not accessible. Another thing I should have mentioned this morning is that these bonefish feed on sipunculid worms and these worms feed on the sand. I had noted earlier that the bonefish are often full of sand (in their stomachs) and this sand comes from the worm. The worms digest away and the sand stays in the intestine for quite a while.

Buckley:
Can you describe this clam that is the number one food item of the bonefish?

Erdman:
It is a pure white clam and has some fine ridges running across it. There is also a related one that has a thinner shell that is eaten by bonefish. The thinner one is white in color but when they get a little bit larger they turn a beautiful pink.

Capt. Parkinson:
Can you tell us the average size of the bonefishes that are netted?

Erdman:
Yes, the average size is about 1 to 1 1/2 pounds. For example 141 out of 146 fish that I caught were in this size range.

Voss:
What size are the bonefish at first maturity?

Erdman:
Males at first maturity are just over three pounds and females are just over four pounds or about four pounds. The males do reach maturity at a smaller size.

Voss:
Do you have any idea how old these fish are?

Erdman:
No, I do not.

A. McErlean:
Is Arenicola, the lug worm, a diet item of the bonefish?

Erdman:
They may enter the diet also but not that I know of.

Voss:
How long are these worms that you get from the stomachs?

Erdman:
Some are about half an inch in diameter. Comment Mowbray, Arenicola which is the worm that lives under the mound of sand is an item of food for the bonefish in Bermuda, at least. Comment Erdman, I think they do eat an occasional heart urchin also.

Chairman Mowbray:
The bonefish also uses the hydraulic mining process of blowing out water from their mouth and clouding up the sand. This also gets sand into their stomach.